# Written Evidence Submitted by the European Marine Energy Centre Limited (EMEC)
# (HNZ0039)

## Executive Summary

EMEC welcomes the opportunity to respond to this timely consultation. By way of summary:

- We welcome the government's ambitions for the role for hydrogen in delivering 'net zero' future energy systems in the UK. While recognising the important role for carbon capture and storage (CCS) in facilitating decarbonisation in some sectors, we encourage the government to focus on de-risking electrolyser deployments and driving 'green' hydrogen production.
- There is great synergy between growing support for marine renewables and the development opportunities offered by decentralised hydrogen production for coastal and island communities.
- At our test sites and in the wider Orkney islands archipelago, EMEC has facilitated a number of first-of-a-kind demonstration projects showcasing innovative means of using electrolytic hydrogen production plants to address energy transmission constraint challenges, and integrate tidal energy convertors into wider energy systems. We have explored a wide range of use cases for hydrogen, especially those most applicable in the island environment, including shipping, aviation and distilling. We have summarised the status of these projects and the lessons learned in the body of our submission.
- There are untapped opportunities for hydrogen fuel development, particularly in heavy emitting sectors such as aviation and shipping. Building upon existing expertise and supply chains in the UK in both of these industries, clear government commitments could drive innovation forward, to help meet 'net zero' commitments whilst creating UK export and leadership opportunities.
- Equally, supporting the development of renewably powered hydrogen production facilities in island communities could offer significant economic opportunities in those areas, helping to deliver a 'Just Transition.'

## Introduction

EMEC was founded in 2003 in Orkney, Scotland and is the only accredited wave and tidal test centre for marine renewable energy in the world. More marine energy devices have been tested at EMEC than at any other single site in the world: EMEC has hosted 20 wave and tidal energy clients (with 32 marine energy devices) spanning 11 countries.

Today we're also pioneering the development of a green hydrogen economy in Orkney, having set up a hydrogen electrolysis plant onshore in 2016, next to our tidal energy substation. With the ability to use locally produced hydrogen to decarbonise across a range of power heat and transport applications, Orkney has become a leading example of a developing hydrogen economy. EMEC support and actively collaborate on hydrogen research projects and offers a demonstration site for new hydrogen technologies. Most recently EMEC's project involvement has focussed on hydrogen demonstration in the maritime and aviation sectors, supporting the decarbonisation of lifeline transport services.

Through our 'learning by doing' approach, we have learned useful lessons for the wider sector and have identified areas in which supporting regimes can be improved to facilitate greater progress in deploying essential future systems. Our evidence is submitted in this spirit.

## 1. Suitability of the Government's 'Driving the Growth of Low Carbon Hydrogen' Plan

1.1 We welcome the government's plans for the development of 'low carbon' hydrogen production capacity in the UK, though we encourage the most ambitious possible level of support for the development of 'green' electrolytic hydrogen production. Developing CCS facilities alongside steam methane reformation hydrogen production plants will be essential to achieving the UK's net zero ambitions, especially in industrial clusters, and clearly offer significant development opportunities for target communities.

1.2 However, these projects should not be pursued preferentially or to the detriment or exclusion of 'green' electrolytic hydrogen production facilities powered by offshore renewable generation technologies including wind, wave and tidal energy convertors. These 'green' approaches offer greater longevity than those reliant upon dwindling fossil fuel sources and can provide significant opportunities for energy system resilience and economic development in coastal and island communities throughout the UK, aligning with government ambitions to deliver 'net zero' while also 'levelling up' our communities.

## 2. Progress of Hydrogen Trials, UK and Abroad, and Next Steps

<u>EMEC Hydrogen Trials and Demonstration Projects</u>

2.1 EMEC has hosted or been involved in several innovative demonstration projects showcasing new approaches to producing and utilising hydrogen, in support of energy system decarbonisation. We installed an electrolyser at our Caldale tidal energy test site on Eday in 2016. In 2017, EMEC produced the world's first tidal-generated hydrogen using power from tidal energy developers Orbital and Tocardo, who were testing tidal energy devices on site. Since then, we have deployed further hydrogen production capacity and demonstrated a number of innovative hydrogen use cases, often in (global) first-of-a-kind projects. We have summarised some of these achievements below.

2.2 Our Surf 'n' Turf project, launched in 2017, brought together partners from different sectors to demonstrate hydrogen use to resolve grid constraint challenges, which were restricting the capacity available for new renewable power deployments in Orkney. This project, funded by Scottish Government, facilitated the installation of our 500 kW electrolyser on Eday. This electrolyser is powered by tidal energy converters tested at our site at the Fall of Warness, as well as wind power generated by a community-owned turbine run by Eday Renewable Energy. The hydrogen produced in Eday is transported to Orkney Mainland by ferry, stored in specially designed tube trailers, landing in Kirkwall. At the pier in Kirkwall, we feed the hydrogen into a fuel cell, which produces electricity from that hydrogen through an electrochemical reaction, with water and heat as the only by-products. The power produced provides auxiliary power to ferries while they are docked in the harbour. As an additional outcome, this project provided significant opportunities for the upskilling of project partner organisations and the local community, especially in regard to safe handling of hydrogen. The Surf 'n' Turf project fundamentally demonstrated the potential to use hydrogen to integrate renewable power generation capacity, specifically tidal generation capacity, while supporting energy system resilience

2.3 Building upon Surf 'n' Turf successes, our pioneering Building Innovative Green Hydrogen Systems in an Isolated Territory (BIG HIT) project launched in 2018, supported by

the European Commission's Fuel Cells and Hydrogen Joint Undertaking (FCH JU). This five-year project brought together 12 partners from six different European countries to further develop hydrogen production capacity and the breadth of use cases in the islands, with a deliberate focus on creating a roadmap for the replication of project outcomes in other island communities internationally. A further electrolyser was deployed on Shapinsay in the course of this project, where it has been powered by a community wind turbine, producing fuel for local use in catalytic boilers which provide heat to a school, demonstrating the use of hydrogen in meeting heat demand cleanly, even in an off-gas network community. The BIG HIT project additionally provided for the deployment of a hydrogen refuelling station on Orkney Mainland, alongside a fleet of electric vans equipped with fuel cell range extenders. Tackling various sources of energy demand in disparate sectors, this project has demonstrated the breadth of possible applications for hydrogen in decarbonisation.

2.4 Indeed, learnings from Surf 'n' Turf and BIG HIT will be exploited through EMEC's participation in work packages aiming specifically to replicate our project successes in Mallorca and the northern Netherlands in the course of further FCH JU projects, Green Hysland and Hydrogen Energy Applications for Valley Environments in Northern Netherlands, respectively. Both projects, commencing in 2021, seek to develop hydrogen-based energy system roadmaps to facilitate deep decarbonisation of power, transport, heating and industry sectors in the target geographies.

2.5 EMEC's further hydrogen activity has focused on developing various use cases to support local decarbonisation of services of strategic importance to our local community, and demonstrate the possibilities available to communities in all islands. Shipping and aviation both provide lifeline services in the Orkney islands, keeping people connected and goods moving. To date both sectors remain firmly fossil-fuelled, however, and are significant sources of greenhouse gas emissions and local air pollution. With this in mind, we have pursued projects seeking to demonstrate cleaner, lower emission alternatives, namely through our Hydrogen Diesel Injection in a Marine Environment (HyDIME) and HyFlyer projects, both funded by Innovate UK. These projects have sought to develop alternative, hydrogen-fuelled solutions in the shipping and aviation sectors, respectively.

2.6 In HyDIME, we have been working with ULEMCo, Ferguson Marine and HSSMI to evaluate the technical feasibility of converting a diesel ferry to operate with a hydrogen-diesel fuel blend, in order to reduce ferry emissions. First-of-a-kind real world testing of this system on board a Shapinsay-Kirkwall ferry was anticipated for the project, however challenges associated with inflexibilities in regulation in the marine environment have limited the scope of possible project activities to ancillary exercises. This project has exposed flaws in the translation of learning from the terrestrial to the marine regulatory environment and the slow development rate of the controlling frameworks.

2.7 Our HyFlyer project captivated imaginations in September 2020 when project partners ZeroAvia made the world's first hydrogen-powered test flight in a converted six-seater Piper M-class aircraft at Cranfield airfield. EMEC has provided hydrogen refuelling equipment for the project, having worked with technology Fuel Cell Systems Ltd to develop a mobile hydrogen truck which dispenses hydrogen at the appropriate pressure airside to fuel the aircraft. The hydrogen is produced on site by EMEC in a specially commissioned electrolyser trailer. The decarbonisation of regional aviation through hydrogen-powered aircrafts is an increasingly tangible possibility following the HyFlyer project's success. The project consortium has secured £12.3 million further funding through the Aerospace Technology Institute programme for HyFlyer II, which will demonstrate a breakthrough 19-seat hydrogen-electric powered aircraft that is market-ready by 2023.

2.8 EMEC also led a Department for Business, Energy and Industrial Strategy (BEIS) Industrial Fuel Switching feasibility study in our HySpirits project, conducted in 2019. Working with the Orkney Distillery, this project focussed on evaluating the technical feasibility of using hydrogen as a fuel to support decarbonisation in distilling. Following the success of this initial study, we have secured Green Distilleries Competition funding for HySpirits 2, in cross-sectoral partnership with academia and local distilling stakeholders, to deliver a broader feasibility study covering an array of technologies, with the potential to demonstrate the world's first 'green' hydrogen powered distillery in a further phase of the programme.

2.9 In common across the HyDIME, HyFlyer and HySpirits projects is a focus on demonstrating the use of hydrogen to decarbonise applications which would be difficult to address comprehensively with electrification alone. Longer distance shipping and aviation, and high-grade, industrial heating applications lend themselves well to hydrogen-based solutions, and our activities have gone some way to showcasing what is currently possible, where ambitions should be focussed in the near future, and what support is required to facilitate further development in these sectors.

Next Steps and Asks

2.10 The projects highlighted above have demonstrated technical feasibility of various hydrogen production, handling and use cases, which are maturing rapidly; the major outstanding challenge is commercialisation of these solutions. The government's 'Ten Point Plan for a Green Industrial Revolution' (1) and BEIS's proposed 'Business Models for Low Carbon Hydrogen Production' (2) suggest strong commitments to both investing in and supporting the development of the UK's emerging hydrogen sector and this is very welcome.

2.11 However, significant commitments to the role for hydrogen in delivering net zero will be required to facilitate further development. De-risking investments in hydrogen production facilities can currently be very challenging, given the absence of secure off-take commitments from not-yet-existent consumers. We look forward to the upcoming Hydrogen Strategy and hope to continue to support efforts to (further) develop supply chains in hydrogen and allied sectors in Orkney, Scotland, the wider UK and further afield. We would certainly also encourage continued investment in hydrogen demonstration activities to further facilitate opportunities to learn from applying these solutions in real world settings.

2.12 EMEC would also particularly draw attention to the need to decarbonise agriculture activities. Orkney is an agrarian community and its use of 'red diesel' is considerable in tractors and others, making agriculture a priority sector in our local decarbonisation efforts. It is unclear if this sector will follow a battery/hydrogen route or a hydrogen derived fuel route. Research, development and demonstration activities should be supported to test new ways of doing things, and to facilitate development opportunities for farms.

2.13 Our project experiences have clearly demonstrated the synergies between developing hydrogen economies alongside marine renewables, particularly in our case through the co-deployment of tidal energy generators and electrolysis plant. Though the Orkney islands are particularly well suited to the deployment of marine energy convertors, there is great scope to replicate our relative success in other UK island and coastal environments. We would thus thoroughly encourage the government to support the marine energy growth, and the potential for ever expanding coastal and island-based green hydrogen production facilities. This will be best accomplished by encouraging wave and tidal energy developers to participate in future Contracts for Difference rounds through provision of ring-fenced capacity

and by ensuring upcoming innovation is supported through an Innovation Power Purchase Agreement. Welcomed mechanisms such as the Net Zero Hydrogen Fund create aligned policy opportunities for the development of hydrogen electrolyser plants in hand with ocean energy technologies.

2.14 The challenges seen in the use of hydrogen in shipping are those of regulation and not physics or chemistry. Codes written for other fuels are silent on hydrogen use and the regulatory environment seems isolated and impervious to terrestrial experiences. In the case of the HyDIME project the understandable lack of experience in the application of hydrogen at sea has driven Orkney to develop training materials for sea staff. Unfortunately, the regulatory experience does not yet exist to provide insight, and key tasks have been outsourced. The resultant contractual interface has further complicated the issue. To date it has not proven possible to engage the regulators' capacity to grant derogations to allow non 'Type Approved' marine engines to be used. It should be noted that such engines do not exist due to the experimental nature of the activity. We recommend that regulators including the Maritime and Coastguard Agency be encouraged to engage in partnership working, to reduce barriers to the innovation that will be essential to deliver our 'net zero' commitments.

2.15 The 2019 UK Clean Maritime Plan (CMP) (3) made strong commitments to reduce shipping emissions whilst outlining clear expectations by 2035 of global UK export leadership, expertise and infrastructural development in the zero-emission propulsion technologies arena. There are great synergies to be made between the CMP and hydrogen net zero commitments. We look forward to greater expansion in this area in the upcoming Hydrogen Strategy. The UK can build on expertise readily tested in regions such as Orkney to drive further innovation and scalability of 'green' hydrogen as a clean fuel for the maritime sector through the The Net Zero Hydrogen Fund and the anticipated revenue mechanisms currently in development.

2.16 There is also an opportunity to build upon activity in shipping decarbonisation to influence the development of the entire fuel sector holistically. The challenges associated with the storage of large volumes of gaseous hydrogen remain considerable and EMEC believes more effort needs to be applied to the conversion of hydrogen into more stable fuels such as ammonia or methanol. Our experience is that the transportation of hydrogen is presently inefficient and we believe there are better ways to achieve energy transfer beyond simply as a compressed gas. Tackling these challenges in the shipping sector, where demand for fuel is high, may facilitate easier transition in other fuel-reliant sectors including agriculture, aviation and perhaps even road transport.

**3. Addressing Engineering and Commercial Challenges**

3.1 A wide range of engineering challenges remain in all aspects of the hydrogen value chain, and we look forward to working with partners in continued testing and demonstration activity to address these. One particular area for future focus, and in which Research and Technology Organisations and accredited testing facilities like ours are especially well placed to contribute, is in the development of the quality monitoring and standardisation systems and processes which will contribute to increasing consumer confidence in hydrogen-based solutions. As the underpinning regulatory framework evolves, (hydrogen) gas quality monitoring solutions will be essential to ensuring safety, technical integrity of hydrogen-consuming appliances, and fairness to individual consumers.

3.2 In the commercial realm, more substantial challenges risk impeding progress in hydrogen deployments. The primary issue for hydrogen project developers currently is a

‘chicken or the egg?’ dilemma, in which investment in hydrogen production facilities is typically contingent on guaranteed demand for the hydrogen, meanwhile growth in demand for hydrogen is restricted by an absence of affordable supply of fuel. Financial support mechanisms and market structure developments could address these challenges. One potential focus point could be widening the Renewable Transport Fuel Obligation (RTFO) to cover further transport sectors including rail and maritime, where hydrogen systems can offer substantial decarbonisation potential. Thiscould help to drive further progress by easing the financial burden associated with adopting hydrogen alternatives in these applications.

## 4. Recommendations

*We recommend for the committee to encourage the Government to –*

- Address regulatory inconsistency barriers which are restricting innovation, particularly in the maritime environment, where restrictions preventing the use of non ‘Type Approved’ engines, even in experimental studies, have hampered demonstration activity. A holistic approach to ensuring regulations evolve in light of emerging evidence from research activity is recommended.
- Ensure that proposed financial supports through RTFO reform and the introduction of revenue mechanisms, as well as other support regimes, are mobilised as soon as possible to assist in de-risking upcoming projects.
- Similarly, facilitate continued research, development and demonstration investment to contribute to further de-risking, and to support the achievement of economies of scale in hydrogen supply chains.
- Consider the synergies between the marine energy and hydrogen sectors, as demonstrated by our experience in Orkney, and leverage support for both to encourage deployment of hydrogen production and utilisation systems in coastal and island communities.

## References

1. **Prime Minister's Office.** PM outlines his Ten Point Plan for a Green Industrial Revolution for 250,000 jobs. [Online] 18th November 2020. [Cited: 7th January 2021.] https://www.gov.uk/government/news/pm-outlines-his-ten-point-plan-for-a-green-industrial-revolution-for-250000-jobs.

2. **Department for Business, Energy and Industrial Strategy.** Business models for low carbon hydrogen production. *www.gov.uk.* [Online] 17th August 2020. [Cited: 7th January 2021.] https://www.gov.uk/government/publications/business-models-for-low-carbon-hydrogen-production.

3. **Department for Transport, Maritime and Coastguard Agency.** Clean Maritime Plan: Maritime 2050 Environment Route Map. *www.gov.uk.* [Online] 11th July 2019. [Cited: 7th January 2021.] https://www.gov.uk/government/publications/clean-maritime-plan-maritime-2050-environment-route-map.

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